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Computerized cardiotocography parameters in pregnant women affected by pregestational diabetes mellitus

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Abstract

Aim: To evaluate whether computerized CTG (cCTG) is a reliable method of predicting neonatal outcome in pregnancies complicated by pregestational diabetes at term.
Patients and methods: We considered 27 pregnant women affected by pregestational diabetes and 46 normal pregnancies as controls that fulfilled the following criteria: singleton, Caucasian, euglycemic pregnancies at term (>37 weeks gestational age). All women delivered by cesarean section (CS), with an antepartum cCTG performed within one hour before the CS and an UBGA available at birth. No patient was in labor during FHR monitoring.
Results: Among cCTG parameters, accelerations 15 bpm, HV min, HV ms and STV were significantly lower in comparison to controls. We observed that in the diabetic pregnant women the parameter STV was not able to predict or to linearly regress with the most important UBGA parameters: pH and pCO_2. Contrarily, in normal pregnancies, the STV linearly regressed with both the pH ($p < 0.03$) and pCO_2 ($p < 0.04$).
Conclusions: Computerized FHR criteria may not be applicable to fetuses in pregestational diabetic pregnancies at term. Therefore some criteria should perhaps be modified for a correct interpretation of cCTG in these pregnancies.

Keywords: Computerized CTG; diabetes; fetal acidemia; umbilical blood gas analysis.

Introduction

Pregnancies affected by diabetes mellitus are at greater risk for fetal death, macrosomia and fetal anomalies as a consequence of poor maternal blood sugar control that causes fetal hyperinsulinaemia [12]. Although the pathophysiologic mechanisms of intrauterine fetal death in diabetic pregnancies are not well understood, signs of fetal asphyxia before or during labor, as demonstrated by pathological FHR recordings, have been reported in up to 21% of cases, suggesting that most of the fetal deaths are preceded by a period of asphyxia [4, 7, 16]. In pregnancies complicated by diabetes, analysis of blood samples obtained by cordocentesis has demonstrated that some fetuses are acidemic [6, 10], a sign of probable hypoxic-ischemic encephalopathy, cardiopulmonary/renal dysfunction and abnormal development [3, 5, 8, 9, 14]. The utility of cardiotocography (CTG) in the detection of fetal acidemia has been widely demonstrated. Nevertheless, in the last decade several authors have demonstrated the limits of CTG in the management of diabetic pregnancies. Pathological FHR recordings have been observed even in diabetic pregnants considered to be in good metabolic control (persistent normoglycemia) [11]. In this study, we aimed to evaluate in single euglycemic pregnancies complicated by pregestational diabetes at term the actual value of computerized CTG (cCTG).

Patients and methods

We performed this study from October 1997 until September 2003 recruiting 27 pregnant women affected by pregestational diabetes, fulfilling the following criteria: singleton, Caucasian normotensive pregnancies at term (>37 weeks gestation) delivered by cesarean section (CS), with an antepartum cCTG performed within one hour before CS and an UBGA analysis available at birth. All diabetic pregnant women presented normoglycaemia during pregnancy. When reaching 37 week's gestation, they were hospitalized at least 24 hours before CS. During this time, periodic glycemic controls were performed in our department with reassuring results. None of the diabetic patients smoked or took any medication that could alter FHR (i.e. betamethasone).

Of all pregestational diabetic cases, 21 were classified as class B, three as class C, two as class D and one as class R using White's classification. In 21 cases Dawes-Redman criteria were met, in six cases criteria for absence of high variation episodes were not met and this constituted the indication for CS.

In the same period we selected as a control group 46 pregnant women that delivered by elective CS for repeated CS or previous miomectomy; they were at similar gestational age to the pregestational diabetic cases and all met Dawes-Redman criteria during FHR tracings. Gestational age (GA) was established on

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Table 1 Description of cases (n=27: 15 males, 12 females) and controls (n=46: 20 males, 26 females).

	Diabetes (n=27)			Controls (n=46)			
	Median	25%	75%	Median	25%	75%	p value
GA (wks)	38.0	37.2	38.3	38.4	37.2	38.5	NS
Birthweight (g)	3415	3110	3700	3260	3000	3530	NS
Apgar 1 min	8	8	9	8	7	9	NS
Apgar 5 min	9	9	10	9	9	10	NS
FHR bpm	137	126	140	137	132	143	NS
Acc 10 bpm	8	4	10	7	5	10	NS
Acc 15 bpm	1	1	5	4	2	6	0.04
HV min	9	4.2	15.2	12	6.7	21.2	0.02
HV ms	15.1	11.9	18.4	17.3	15.3	20.4	0.01
LV min	6	0	12.2	5	0	11.2	NS
LV ms	0	0	6.4	4.5	0	6.9	NS
STV	7.4	5.6	8.6	8.3	6.3	9.2	0.02
FM	22	13	56	30.5	17	53	NS
pH	7.22	7.20	7.27	7.28	7.25	7.31	0.003
pCO_2	59.8	53.1	65.4	51.9	48.2	56.8	0.001
HCO_3^-	24.7	23.3	26.5	23.7	22.4	25.1	NS
pO_2	16.6	14.6	19.6	15.4	11.8	18.8	NS
Sat O_2	15.9	8.8	23.5	13.6	6.2	20.4	NS

GA: Gestational age, Acc: Accelerations, HV: High variation, LV: Low variation; STV: Short term variability, FM: Fetal movements.

the basis of the last menstrual period and confirmed by the first ultrasound scan. No pregnant woman was in labor during FHR monitoring.

The cCTG was interpreted as described elsewhere [1]. FHR recording was performed by means of an automated system interpreted by an Oxford 8002 software (Manor Way, Old Working Surrey; England). All traces lasted at least 40 min. Analysis is based on the evaluation of different FHR trace parameters (FHR within normal range, absence of large decelerations, presence of high variation episodes, presence of at least three accelerations, STV >3 ms, absence of sinusoidal rhythm).

UBGA was performed on a double clamped segment of the umbilical cord before the first neonatal breath using an AVL compact 2 analyzer, following usual procedure [1, 2]. UBGA of umbilical artery included: pH, pCO_2, BE, HCO_3, pO_2 and O_2 saturation (O_2 Sat).

All diabetic pregnancies were delivered under general anesthesia; 20% of controls were administered epidural anesthesia vs. 80% general anesthesia. We compared differences in CTG parameters in control subgroups (general and epidural anesthesia) against cases, and the same trend as shown in Table 1 was found (lower Acc 15, HV min, HV ms in and STV in cases).

No major complications were documented in the interval (never more than one hour) between the FHR tracing and delivery (i.e. abruptio placentae). Neonates were evaluated by neonatologist staff unaware of the study being conducted by our Department.

Statistical analysis

To analyze differences between groups, a Kolmogorov-Smirnoff test was performed in order to determine a normal distribution (Gaussian). When the test for normality did not satisfy the criteria of Gaussian distribution, a no-parametric test was performed. For the statistic correlations, we performed the Pearson test. When significant correlations were found, a simple regression was run. Statistical analysis was performed by means of Sigma Stat 2.03 (Jandel Scientific, Ekrath, Germany). We considered $p<0.05$ as statistically significant.

Results

The characteristics of the study group and controls are displayed in Table 1. Gestational age at birth, birth weight, and Apgar scores at 1 and 5 min were not different between groups. Four neonates of the diabetic group, representing 14% (4/27), presented an umbilical artery pH<7.2 at birth and four neonates in controls, representing 8% (4/46), had an umbilical artery pH<7.2 at birth. No newborn required intubation or presented neonatal complications.

Among cCTG parameters, Acc 15, HV min, HV ms and STV were significantly lower in cases compared to controls. Concerning UBGA values, only pH and pCO_2 differed between groups. Subsequently, we decided to correlate cCTG with UBGA parameters that were significantly different between groups (Acc 15, HV min, HV ms and STV; pH and pCO_2). We verified that in the diabetic group, the cCTG parameters evaluated were not able to predict or to linearly regress with UBGA parameters (pH and pCO_2). Conversely, for the normal pregnancies STV was the sole parameter that linearly regressed directly with pH ($p<0.03$) and inversely with pCO_2 ($p<0.04$).

The number of cases in the Diabetic group regarding STV values were as follows: STV <5=6 (22%), STV 6–9=17 (62%), STV >10=4 (15%), while in controls number of pregnant women for STV values were as follows: STV <5=6 (13%), STV 6–9=34 (74%), STV >10=6 (13%).

When correlating cCTG with other neonatal parameters, we found no significant correlation with Apgar scores at 1 min and 5 min in both groups.

Discussion

Since there is a strong inverse correlation between maternal blood glucose and fetal blood pH [10], it may be possible that an acute elevation in maternal blood glucose could result in sudden, severe fetal acidosis and death. The degree of fetal acidemia in diabetic pregnancies may be related to short term rather than to long term glycemic control for the above-mentioned significant association between fetal umbilical blood pH and both fetal and maternal glucose concentration. For this reason, it would be not surprising if fetal death occurred soon after normal assessment.

Salvesan et al. [10], collecting fetal blood by cordocentesis immediately after a cCTG trace, described how FHR variation provides poor prediction of fetal acidemia, concluding that, if unexplained, fetal death is a consequence of acute acid-base disturbance. Other authors have demonstrated that recordings not meeting Dawes-Redman criteria in diabetic pregnancies do not necessarily predict neonatal complications. Tincello et al. [13] described, on the basis of the evaluation of 233 cCTG traces of patients with diabetes mellitus between 27 and 38 weeks of pregnancy, that 71 (30.5%) failed to meet Dawes-Redman criteria due to the absence of episodes of high variation, without any apparent difference in the incidence of serious neonatal complications in the infants with abnormal monitoring compared to those with normal. The same authors confirmed that the absence of episodes of high variation, more frequent in diabetic pregnancies, is not an ominous finding in these fetuses, since there was no evidence of adverse neonatal outcome in the group of women where such episodes were absent. Furthermore, for these fetuses, at term, they observed significantly higher basal FHR and significantly lower accelerations and STV in comparison to controls.

In order to explain these findings, Weiner et al. [15] proposed a considerable delay in the normal maturational changes in FHR pattern for fetuses of mothers with diabetes class A, and a lack of such mechanisms in women with diabetes class B-R, more evident in the second half of the third trimester, when FHR variation and frequency of accelerations become significantly lower than in fetuses of non-diabetic mothers.

We observed that high variation expressed in min and ms, STV and accelerations 15 sec were significantly lower in the diabetic group compared to controls. Moreover, we found that the above-mentioned parameters did not linearly regress with and were not able to predict pH and pCO_2. Conversely, in the normal pregnancies, the STV linearly regressed with both the pH and the pCO_2.

Since deliveries were programmed in diabetic cases, strict outpatient follow-up was performed until cesarean section.

Our data confirm the utility of the cCTG, and particularly of the STV, in the prediction of the pH and the pCO_2 of the umbilical artery in normal pregnancies [2]. The unreliability of cCTG in diabetic pregnancies is probably due to the basal condition of acidemia and fetal hypercapnia induced by the fetal hyperinsulinemia.

However, maternal glycemic values are just one sign of the pathology. Even in euglycemic pregnant women, certain biochemical changes that cannot be detected using methods such as CTG, Doppler velocimetry, biochemical tests etc., may affect these pregnancies.

We conclude that we cannot attribute to cCTG the same reliability in diabetic pregnancies as we do for normal pregnancies, although all diabetic women present in euglycemic conditions. Therefore some criteria should perhaps be modified for the correct interpretation of FHR recordings in these patients.

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